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ROOST RECRUITMENT AND RESOURCE UTILIZATION: OBSERVATIONS ON A *HELICONIUS CHARITONIA* L. ROOST IN MEXICO (NYMPHALIDAE)

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ABSTRACT. A communal roost of individually marked *Heliconius charitonia* L. (Nymphalidae) butterflies was observed over a three week period in southern Mexico. Pollen plants (*Anguria*, Cucurbitaceae), which serve as adult resources for these butterflies, were monitored for butterfly visits during this time. Roost members were generally using separate pollen plants from non-roost member *H. charitonia*. Predation on a roost member was observed at one of these plants. Fresh *H. charitonia* were observed associating with roost members first at a pollen plant during the day and later that evening at the roost site, indicating that the new recruits followed the older butterflies to the roost. Observations are discussed in regard to current hypotheses about gregarious roosting.

Many species of birds, solitary bees and wasps, bats and butterflies roost communally. In most cases, members depart from the roost on a circadian schedule to forage, returning to the site to sleep. Roosts may be diurnal or nocturnal, seasonal or permanent, mono- or multispecific.

There are two major hypotheses concerning why animals roost together. One hypothesis suggests that communal roosts protect members from predation, either because animals in groups are quickly alerted to predator presence (Gadgil, 1972), or because the species is unpalatable (Benson, 1971; Turner, 1975). The second hypothesis proposes that roosts serve as centers of information exchange about food resources (Ward & Zahavi, 1973; Gilbert, 1975). At present, there are too few data on roost dynamics in any species to fully assess the relative importances of these two hypotheses.

Some species of the brightly-colored Neotropical *Heliconius* (Nymphalidae) butterflies characteristically form nocturnal communal roosts. Members of these roosts often home repeatedly to the same site every night (Benson, 1971). Gilbert (1975) has suggested that new recruits to *Heliconius* roosts follow experienced roost members from the roost site when they forage in order to learn the locations of pollen plants, which serve as important adult food sources for these long-lived butterflies (Dunlap-Pianka et al., 1977). Following behavior by conspecific *Heliconius* has often been observed in the field, but there is no information on following by members of the same roost. Similarly, there is no substantial information on patterns of resource utilization by roost members of *Heliconius* butterflies.

In our study of a *Heliconius charitonia* L. roost in Mexico, we observed fresh butterflies associating with roost members first on a pollen plant during the day, and later that evening at a roost site, indicating that the new recruits found the roost site by following the older butterflies. We also obtained evidence that roost membership is closely tied to resource use.

METHODS

Heliconius Butterflies

Heliconius are aposematic Neotropical butterflies with limited home ranges (Ehrlich & Gilbert, 1973). Individuals often live and reproduce for six months or longer. Both sexes make repeated visits to adult food plants for pollen and nectar, and to larval host plants for ovipositions (females) and mate-finding (males). It is therefore possible to monitor home range movements and resource utilization by individual roost members.

Heliconius charitonia is a brown and yellow zebra-striped inhabitant of forest edge and secondary growth habitats. This species forms low, cryptic nocturnal roosts, sometimes with other *Heliconius* species.

Study Site

Observations were made at the Estación de Biología Tropical "Los Tuxtlas" UNAM, near the town of Catemaco, Veracruz, Mexico. The Station is located on 700 ha of primary tropical rainforest and secondary growth. Altitude ranges from 150 m to 530 m. The mean annual temperature is 24°C, and the average precipitation is 4560 mm per year. This study was conducted in July and August 1978, approximately one month into the wet season.

Roost

The roost observed during this study was located next to a stream bed in a clearing that had been created by a tree fall (see Fig. 1). Two adjacent but discrete subroosts were used by the butterflies; these were approximately 3 and 4 meters high, respectively. Butterflies occasionally roosted high in branches above both subroosts.

Adult Food Plants

Anguria tabascensis Donn. Smith (Cucurbitaceae) lianas were the major pollen sources for *H. charitonia* at the Station. Eight of these plants were monitored for visits by *Heliconius* butterflies. Plants A1, A2, A3, A4, A5, A7 and A8 were flowering at eye level, and numbers of butterfly visitors could be read off the wings without disturbing

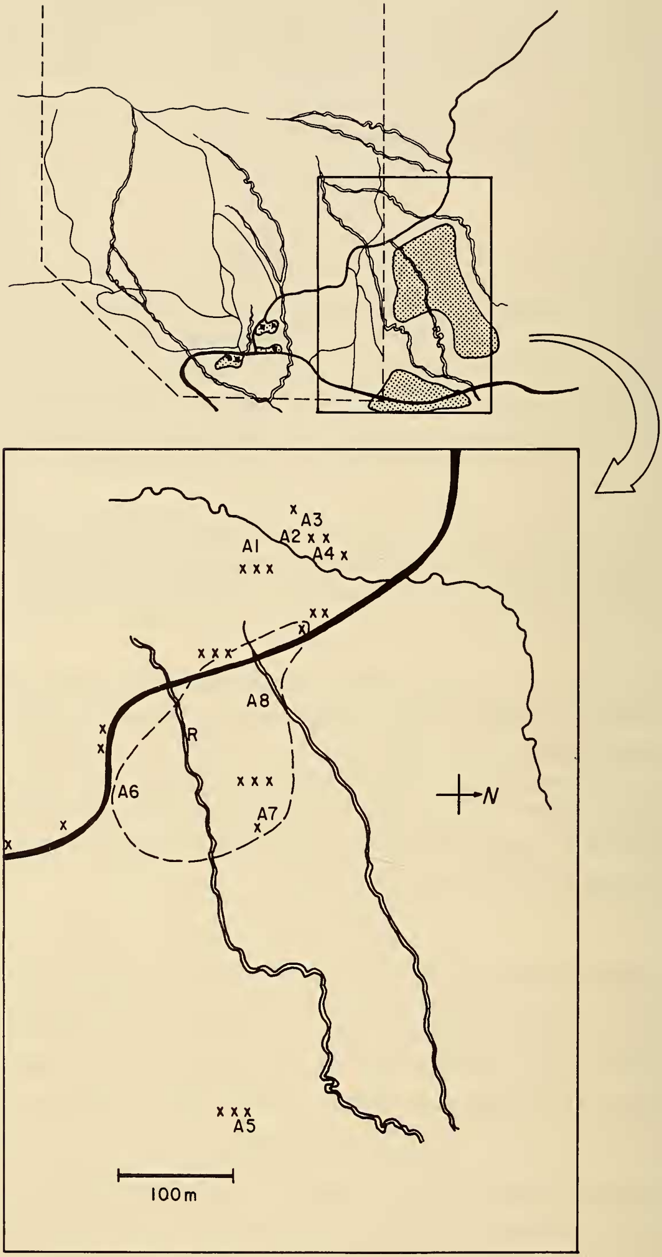

FIG. 1. Map of roost and surrounding area at the Estación Biología Tropical "Los Tuxtlas" UNAM, Veracruz, Mexico, including locations of *Anguria* pollen plants A1, A2, A3, A4, A5, A6, A7 and A8. Roost member *H. charitonia* captures and sightings

the butterflies. A6 was a large vine flowering 22 meters in the canopy. Butterfly visitors to A6 were identified using binoculars and a Questar 3 telescope. Fig. 1 shows the locations of the roost and of *Anguria* plants A1–A8.

Procedure for Observation

Butterflies were observed on the roost through binoculars mornings and evenings from 18 July–6 August 1978, and evenings only from 6 August–10 August 1978. Roost members were caught at *Anguria* plants during the day, or netted as they left the roost in the morning. They were numbered at these times on the forewings with black marking pen. Butterflies were scored for sex and wingwear as fresh (F: less than 1 month old), intermediate (I: between 1 and 3 months old), or worn (W: over 3 months old), following Ehrlich and Gilbert (1973).

RESULTS

Roost Fidelity

When the roost was first discovered on 17 July 1978, it was composed entirely of worn and intermediate butterflies. No fresh butterflies were observed at the roost site until ten days later on 27 July.

Individual butterflies were highly faithful to the roost (see Fig. 2). The average roost member spent 11.4 nights on the roost during the three week period. Of those butterflies that spent more than one night on the roost (24 out of 27 butterflies), the average roost member was on the roost 87% of the nights during the time the butterfly was first and last observed at the site. Other studies of *H. charitonia* roosts have found roost membership to be less constant (Young & Carolan, 1976; Young, 1978). We attribute some of the high fidelity we observed to our avoidance of disturbing roosting animals for marking. It has been established that capture may drastically affect recapture of mud-puddling butterflies (Singer & Wedlake, 1981).

Resource Utilization

Another factor that may have contributed to the high roost fidelity observed in this study was the presence of a large pollen source 50 m from the roost site. This *Anguria* plant, A6, was located 22 m in

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were confined within the dotted line surrounding the roost site. Non-roost member *H. charitonia* captures and sightings are indicated by x's. Dark solid lines represent roads and paired wavy lines represent streams. (We thank Alejandro Estrada for access to this map which was made by his group for howler monkey population studies.)

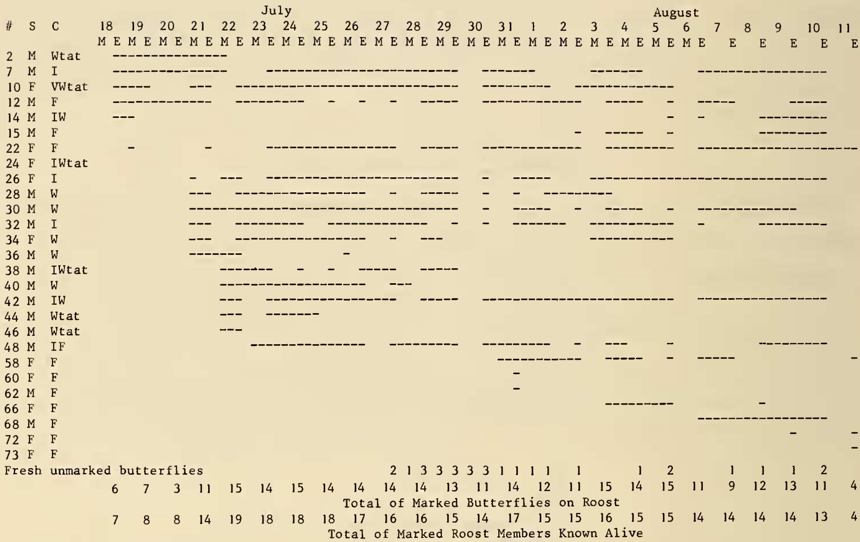

FIG. 2. Mornings (M) and evenings (E) butterflies were observed on the roost. Sex (S) and condition (C) of roost members are indicated.

the canopy and bore more than 33 male inflorescences. More than half of the roost members (11 of 19 marked butterflies at the time of observation) were seen visiting flowers at A6, often repeatedly. A6 was observed for a total of six hours over three separate days.

Other butterfly species, including other heliconiines, also visited A6. However, with the exception of one worn, unmarked butterfly, the *H. charitonia* observed at A6 were all roost members. The almost exclusive use of this resource by roost members was especially striking since non-roost member *H. charitonia* were repeatedly observed flying in the road below A6.

Roost members also visited two *Anguria* that were growing at the edge of a cultivated field just north of the roost site. In four hours of observations (three separate days), seven roost members (Numbers 7, 10, 12, 15, 24, 26, and 42) were seen at A7. Only one non-roost member was caught and marked at A7. In over three hours of observations (four separate days), two *H. charitonia* roost members (Numbers 24 and 58) made repeated visits to A8. Most of the roost members at A7 were also seen in the canopy at A6 (Numbers 7, 10, 12, 26, and 42), but visitors to A8 were never seen at A6.

Anguria plants A1, A2, A3, A4 and A5 were monitored for *Heliconius* visits throughout the study. *Heliconius erato, H. doris, H. ismenius*, and *H. charitonia* were caught and marked at these plants from 7 July 1978, through 7 August 1978. No roost members were ever observed to visit these flowers, and none of the 21 *H. charitonia* marked at these plants appeared at the roost site.

Predation at Resource

One worn roost member (Number 46, W male) was killed but apparently not eaten in the presence of roost mates at A6 by a tanager (Thraupidae). This observation made with the Questar suggests that, through their use of the same favorite pollen plants, roost mates provide a context for the operation of visual selection by predators, even away from the roost. This is in accord with Benson's (1971) and Turner's (1975) models that link roosting behavior with distastefulness and aposematic coloration in *Heliconius* butterflies.

Roost Recruitment

On the morning of 27 July 1978, two fresh *H. charitonia* butterflies appeared at A6 in the canopy, one with a distinct reddish cast to its wings. These fresh butterflies associated with roost members No. 38 (I male) and No. 40 (W male) on the flowers. That evening, two fresh butterflies, one with a distinct reddish cast to its wings, appeared at the roost site for the first time since the commencement of observations 10 days previously. One new recruit roosted with the group, and the other roosted with No. 38 on a branch away from the other butterflies. Although it cannot be documented that the two fresh butterflies sighted at A6 were the same that joined the roost in the evening, the circumstantial evidence strongly suggests that they were.

DISCUSSION

Our observations indicate that roost members were using separate pollen sources from those of non-roost member *H. charitonia*. Whether or not roost members learn the locations of these plants from each other remains to be investigated. This finding does suggest, however, that roost membership is somehow tied to patterns of adult resource utilization. If roost members associate in space and time at pollen plants, then predators need not visit the roost to learn or reinforce avoidance of one roost member through experience with another.

New recruits associated with roost members first on a pollen plant, and later at the roost site, apparently following the experienced butterflies to the roost. This observation suggests a mechanism for roost recruitment. Mature butterflies continually canvass larval host plants (*Passiflora* spp., Passifloraceae), with females in search of oviposition sites and males in search of female pupae. New butterflies emerging in the vicinity of *Passiflora* plants may be attracted to older butterflies when they visit and follow them to flowers and then to the roost or perhaps directly to the roost site. They might also seek out pollen plants and follow experienced butterflies from there to the roost. However, it is not likely that a new individual would locate a plant like A6 easily without following other butterflies, since *Anguria* are generally inconspicuous, at least to human observers. Later foraging from the roost by experienced individuals may not involve the same following behavior which led to the roost's discovery. Indeed, we did not observe following between established roost mates.

These brief observations indicate the feasibility of relating roost membership to foraging behavior, interindividual interactions, and predation of individually numbered *Heliconius* butterflies in the field. We suspect that the major hypotheses for site-constant gregarious roosting (predator protection versus information center) in *Heliconius* will be difficult to clearly distinguish since, regardless of the reason for the evolution of the habit, other advantages to communal roosting may arise secondarily. The most certain conclusion is that *Heliconius* roosting behavior remains one of the major mysteries of lepidopteran biology and as such, deserves further study.

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